THE HISTORY OF PHOTOGRAPHY

Beaumont Newhall

2 • INVENTION

The first person to attempt to record the camera image by means of the action of light was Thomas Wedgwood, son of the famous British potter. He was familiar with the camera obscura, which was used by the pottery to make sketches of country houses for the decoration of plates. And he knew of Schulze's discovery of the light sensitivity of silver salts. Sometime shortly before 1800 he began experiments by sensitizing paper or leather with silver nitrate and then placing flat objects or painted transparencies in contact with it and exposing the whole to light. His friend Sir Humphry Davy described the process in the *Journals of the Royal Institution* for 1802:

White paper, or white leather, moistened with solution of nitrate of silver, undergoes no change when kept in a dark place; but, on being exposed to day light, it speedily changes colour, and, after passing through different shades of grey and brown, becomes at length nearly black...

When the shadow of any figure is thrown upon the prepared surface, the part concealed by it remains white, and the other parts speedily become dark.

For copying paintings on glass, the solution should be applied on leather; and, in this case, it is more readily acted upon than when paper is used.[1]

Wedgwood was dismayed that these "sun prints" were not permanent. He found no way to desensitize the unexposed areas of the prepared paper or leather. Only by keeping his results in darkness could they be prevented from becoming total dark blankness: he showed them almost furtively, by the light of a candle. He was also disappointed that his attempts to record the camera's image—"the first object of Mr. Wedgwood in his researches on the subject," wrote Davy—were unsuccessful. Silver nitrate, we now know, is light sensitive only in the presence of organic substances, such as paper or leather, but even so, its sensitivity is weak compared to such other compounds as silver chloride.

Ill health forced Wedgwood to abandon further experiments, and all that remains is the account by Davy, who concluded: "Nothing but a method of preventing the unshaded parts of the delineation from being coloured by exposure to the day is wanting, to render the process as useful as it is elegant."

Joseph Nicéphore Niépce, of Chalon-sur-Saône in central France, was more successful. Although the only example of his camera work that remains today appears to have been made in 1827, his letters leave no doubt that he had succeeded in fixing the camera's image a decade earlier.

Nicéphore Niépce and his brother, Claude, were ardent inventors. They had patented an internal combustion engine powered by the intermittent explosion of lycopodium powder to which they gave the name *Pyréolophore*; with it they drove a boat against the current of the Saône River. When lithography was introduced to France in 1815, Nicéphore proposed replacing the heavy, cumbersome Solenhofen stones used by the inventor, Aloys Senefelder, with coated metal plates. For his experiments he needed drawings, but since he had little artistic skill he conceived the idea of making them by means of light. On April 1, 1816 he wrote his brother in London, where he was attempting to promote the Pyréolophore, of his results using paper sensitized with silver chloride:

The experiments that I have thus far made lead me to believe that my process will succeed as far as the principal effect is concerned, but I must succeed in fixing the colors; this is what occupies me at the moment, and it is most difficult.[2]

A few days later he described his camera as "a kind of artificial eye, simply a little box, each side six inches square; which will be fitted with a tube that can be lengthened and carrying a lenticular glass."[3]

He broke the lens and had to make a new camera, smaller in size—about 1¼ inches on each side—because the only other lens he had was from his solar microscope and consequently of short focal length. He wrote his brother on May 5, 1816:

I placed the apparatus in the room where I work, facing the bird-house and the open window. I made the experiment according to the process which you know, my dear friend, and I saw on the white paper all that part of the bird-house which can be seen from the window and a faint image of the window sashes which were less illuminated than the exterior objects. . . . This is only a very imperfect attempt. . . . The possibility of painting in this

ISAAC BRIOT. *Portrait of Georges d'Amboise, Cardinal and Archbishop of Reims, France.* ca. 1650. Engraving. Collection Van Deren Coke, San Francisco.

NICEPHORE NIEPCE. *Copy of Engraving of Cardinal d'Amboise.* 1826. Heliograph. Science Museum, London.

way seems to me almost demonstrated. . . . That which you have foreseen has happened. The background of the picture is black, and the objects white, that is, lighter than the background.[4]

This is an accurate description of a negative. Had Niépce only been able to make prints from these negatives he could have again inverted the tones so that they would correspond to the order of lights and shades in nature. But he could not find a way to do so, and began to search for a substance that would bleach instead of darken in light. His experiments were fruitless. Then he found that a certain form of asphalt, called bitumen of Judea, was light sensitive. The substance was used by etchers to coat copper plates before drawing upon them; it served as a ground to protect the plate when lines scratched through it by the draftsman were bitten by acid. Normally soluble in oil of lavender, on exposure to light the bitumen hardened, and became insoluble in the oil. Niépce made copies of engravings by oiling them and placing them in contact with the sensitized plate. Isidore, Niépce's son, recollected that his father in 1826

spread on a well-polished pewter plate bitumen of Judea dissolved in Dippel's oil.* On this varnish he placed the engraving to be reproduced, which had been made translucent, and exposed the whole to the light. After a more or less long time, according to the intensity of the light, he plunged the plate in a solvent which, little by little, made the image—until then invisible—appear.

After these different operations, he placed it in more or less acidified water, for the purpose of etching it.

My father sent this plate to [the engraver Augustin Francois] Lemaître, requesting him to be good enough to engrave the drawing still deeper. M. Lemaître acceded very courteously to my father's request. He pulled several proofs of the portrait of Cardinal d'Amboise. . . .[5]

The printed lines of the engraving held back the light; the white paper permitted it to pass through. Thus most of the bitumen was rendered insoluble, but that which lay directly beneath the lines remained soluble and could be removed by the lavender oil. The bared metal was then etched to form a printing plate.

The plate, reproducing a seventeenth-century engraving by Isaac Briot of Georges d'Amboise, Cardinal and Archbishop of Rheims, still exists. Excellent proofs were pulled from it as late as 1870.

This invention is epochal. It was the first of those photomechanical techniques that were soon to revolutionize the graphic arts by eliminating the hand of man in the reproduction of pictures of all kinds. It is the most important of Niépce's contributions, for it involved a principle that became basic to future techniques: the differential hardening by light of a ground that would control the

*Johann Konrad Dippel (1673–1734) a German chemist, prepared a curative oil by distilling animal bones.

etching in exact counterpart of the image.

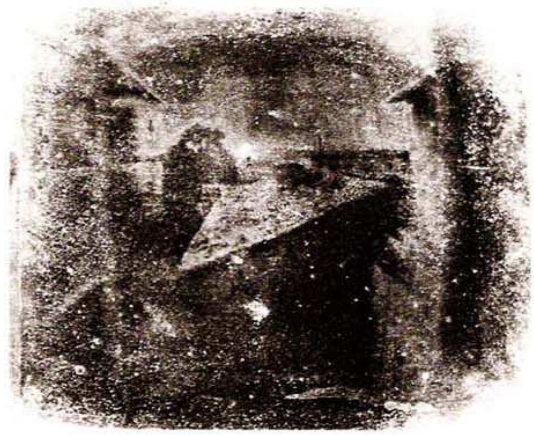
Beside the production of etched plates, Niépce used his bitumen process for making direct positives on metal and also glass plates. After exposure he washed the bitumen-coated plate in his solvent, which laid bare the plate in those parts where little light had fallen. He now put the plate face down on top of an open box containing iodine. This element becomes gaseous at room temperature, and the fumes darkened the plate in the shadowy areas.

Niépce now tried to record the camera image with his bitumen plates. He met with indifferent success, to judge from the only example known to exist: a view taken from an upper window in his estate "Le Gras" in the village of Saint Loup de Varenne, near Chalon-sur-Saône. The plate, now in the Gernsheim Collection of the University of Texas at Austin, shows the open casement and outbuildings in the farmyard.

The exposure was said to have lasted some eight hours; during that time the sun in its travels from east to west lighted both sides of the buildings, destroying the modeling. The image is laterally reversed: left and right are transposed, as in a mirror. The plate, which is of pewter, is not dated, but external evidence points to its production in 1827. A far more successful picture on glass, of a table set for a meal, was presented to the French Society of Photography in 1890 by a member of the Niépce family. The objects—a bottle, a knife, a spoon, a bowl and saucer, a wine glass, and a loaf of bread—are well defined, with middle tones, highlights, and cast shadows. The image alone exists in a coarse halftone reproduction in the Society's *Bulletin*; the original glass plate mysteriously disappeared from the collection not long after its acquisition. A date for the production of this still life has not been determined.

In 1827 Niépce traveled to London to visit his brother, Claude, who was ill; he took with him the farmyard picture and other *heliographs*, as he named the process. On his way he stopped in Paris, where he visited the painter Louis Jacques Mandé Daguerre, who was conducting research toward the same end: capturing the camera image by "the spontaneous action of light."

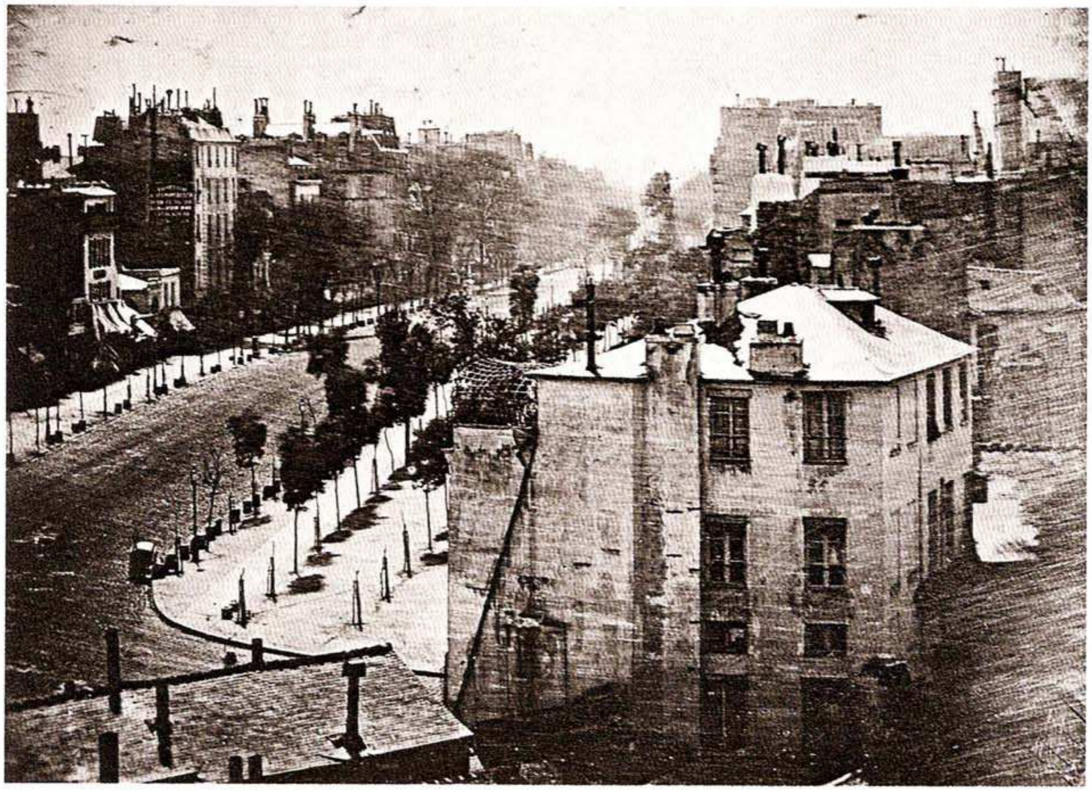
Daguerre was a scenic artist; he had specialized in painting stage sets for the Opéra and popular theaters. At the time Niépce visited him he and his partner, Charles Marie Bouton, were proprietors of the *Diorama,* a theater built for the display of huge 46 x 72-foot paintings of the most illusionistic kind. Semitransparent theatrical gauze was painted on both sides; on changing the lighting from front to back by adjusting curtains on the skylights and floor-to-ceiling windows behind the stage, one image could be made to dissolve into the other. To produce these paintings Daguerre and Bouton made fre-



NICEPHORE NIEPCE. *View from his Window at Le Gras.* ca. 1827. Heliograph. Gernsheim Collection, Humanities Research Center, University of Texas, Austin.

"Though the image can clearly be seen by holding the plate at an angle against the light, or by reflecting light on it by means of a white cardboard to increase the contrast, the picture presented the greatest difficulty in reproduction, because the plate is as shiny as a mirror, and the image rather faint. . . . Our thanks are due to Mr. P. B. Watt of the Kodak Research Laboratory, who after many trials successfully overcame the difficult problem of reproducing the picture."—Helmut and Alison Gernsheim, *Photographic Journal,* May 1952.

NICEPHORE NIEPCE. *Set Table.* ca. 1827. Heliograph. No longer extant. From A. Davanne and Maurice Bucquet, *Le Musée rétrospectif de la photographie à l'Exposition Universelle de 1900* (Paris: 1903).



quent use of the camera obscura to assure correct perspective, and it was his familiarity with this instrument that led Daguerre toward photographic experimentation. He had learned of Niépce's work through the optician Charles Chevalier, who had supplied him with lenses and told him Niépce was also his customer.

Niépce reported on his visit to his son, Isidore, in a letter dated September 2–4, 1827:

I have had frequent and very long interviews with M. Daguerre. He came to see us yesterday. His meeting lasted for three hours . . . and the conversation on the subject which interests us is really endless. . . . I have seen nothing here that impressed me more, that gave me more pleasure, than the Diorama. We were conducted through it by M. Daguerre, and we were able to contemplate the magnificent tableaux which are exhibited there, quite at our ease. . . . Nothing is superior to the two views painted by M. Daguerre; one of Edinburgh taken by moonlight during a fire; the other of a Swiss village, looking down a wide street, facing a mountain of tremendous height, covered with eternal snow. These representations are so real, even in their smallest detail, that one believes that he actually sees rustic and wild nature, with all the illusion that the charm of colors and the magic of chiaroscuro can give it. The illusion is even so great that one is tempted to leave one's box and wander out into the open and climb to the summit of the mountain. I assure you there is not the least exaggeration on my part, the objects are, or seem to be, of natural size.[6]

In London Niépce met Francis Bauer, a horticulturist and a member of the Royal Society, who urged him to communicate his experiments to that learned body. The Society, however, refused to accept any communication that did not disclose the process, and Niépce would not reveal his technique. He gave Bauer the plates he had brought with him, including the farmyard view, the portrait of Cardinal d'Amboise, and a copy of an aquatint of a stage set painted by Daguerre for the play *Elodie*, which he may well have made expressly for Daguerre as a demonstration. He also gave Bauer the manuscript of an account of his process that he planned to publish.

Discouraged by the lack of interest in England in heliography and by his brother's worsening physical and mental health, Niépce returned to France in 1829, determined to concentrate on what he called "view points" (*points de vue*) with the "sole object to copy nature with the greatest fidelity." He reopened correspondence with Daguerre. The showman advised him to postpone his proposed book: "As regards your intention of publishing your method, there should be found some way of getting a large profit out of it before publication, apart from the honor the invention will do you, but for that is needed a degree of perfection that can only be reached

in several years."[7] Lemaître, his Parisian engraver, criticized one of Niépce's "view points" for its contradictory shadows cast by the sun during the excessively long exposure time. Niépce replied:

Unfortunately I am not able to avoid it. . . . It would be necessary to have a camera as perfect as M. Daguerre's; otherwise I shall be condemned to approach the goal without ever reaching it. . . . Therefore I am hastening to reply to his kind offers of help by proposing that he cooperate with me in perfecting my heliographic process.[8]

On December 4, 1829, Niépce and Daguerre signed articles of partnership to last ten years. Only four had run their course when Niépce died in Chalon-sur-Saône.

Daguerre continued alone. Although Isidore Niépce had succeeded to the partnership, he contributed nothing, in spite of Daguerre's constant urging. News of his secret experiments leaked out. Reviewing the Diorama show "The Valley of Goldau" in 1835, the *Journal des Artistes* noted that Daguerre

has found out a method of receiving, on a plate prepared by him, the image produced by the camera obscura, so that a portrait, a landscape or view of any kind, projected upon this plate by the ordinary camera obscura, *leaves its impress* there in light and shade, and thus makes the most perfect of drawings. A preparation applied to this image preserves it for an indefinite period. Physical science has, perhaps, never offered a marvel comparable to this.[9]

The announcement was somewhat premature, to judge from a letter to the editor published in the following year: "I doubt if M. Daguerre has reached the complete results attributed to him. If he had . . . it is very probable that he would have exhibited them . . . he would have had to make a night album, enclosing his results within black envelopes and displaying them only by moonlight."[10]

By 1837 Daguerre had made a highly successful photograph—a still life of plaster casts, a wicker-covered bottle, a framed drawing, and a drapery. This astonishing picture is fully detailed, showing a wide range of tones between highlight and shadow, convincing realism in texture, contour, and volume. It still exists, signed and dated, in the collection of the Société Française de Photographie in Paris. The earliest surviving example of what Daguerre now called the *daguerreotype*, it exhibits the potentials of a new graphic medium that was to revolutionize picture making.

The daguerreotype is on a silver-plated sheet of copper, 6½ x 8½ inches in size. As Daguerre later described his technique, he polished the silver side of the plate mirror bright and chemically clean. He sensitized it by putting it silver side down over a box containing particles of iodine, the fumes of which reacted with the silver to form light-sensitive silver iodide on the surface of the plate. He then exposed it in a camera. The light forming the optical image reduced the silver iodide to silver in proportion to its intensity. Daguerre next placed the exposed plate, which bore no visible image, over a box containing heated mercury; its fumes formed an amalgam with the freshly reduced silver and an image became visible. The plate was then bathed with a strong solution of common salt (sodium chloride), which rendered the unexposed silver iodide relatively insensitive to further light action. Finally, the plate was washed in water and dried.

The result was a record of the lights of the image in frosted, whitish mercury amalgam. The shadows were represented by the relatively bare mirror surface of the plate; when viewed so as to reflect a dark field, the picture appeared positive.

Daguerre now presented a new contract to his partner, Isidore Niépce. He made it clear that he considered the invention to be his own, and agreed to transfer it to the partnership "on *condition* that this new process shall bear the *name of Daguerre* alone; it may, however, only be published simultaneously with the first process, in order that the name of M. Joseph-Nicéphore Niépce may always figure, as it should, in this invention."[11] The contract concluded with details of a plan to sell technical specifications of their separate and different processes by offering 400 subscriptions at 1000 francs each.

Isidore reluctantly signed the contract, although he considered it an insult to his father's memory and unfair, if not dishonest. But in truth Daguerre was correct in claiming the new process as his own. If Nicéphore Niépce knew of the light sensitivity of silver iodide, there is no record that he made use of this property: to him iodine fumes were useful for darkening the bared pewter of his heliographs, and his only existing work involved a quite different photochemical reaction.

Daguerre printed a broadside describing his invention in general terms, and announced the forthcoming sale of technical specifications. But the plan was abandoned at the advice of François Arago, a well-known scientist, director of the Paris Observatory, perpetual secretary of the Academy of Sciences, and a member of the Chamber of Deputies of the French government. He proposed nothing short of the outright purchase of both processes by the state, and told Daguerre that he would call a meeting of the Academy for that purpose.

The newspaper *Gazette de France* wrote in its January 6, 1839 edition:

We announce an important discovery of our famous painter of the Diorama, M. Daguerre. This discovery partakes of the prodigious. It upsets all scientific theories of light and optics, and it will revolutionize the art of drawing.

M. Daguerre has found the way to fix the images which paint themselves within a camera obscura, so that these images are no longer transient reflections of objects, but their fixed and everlasting impress which, like a painting or engraving, can be taken away from the presence of the objects.

Imagine the faithfulness of nature's image reproduced in the camera and add to it the work of the sun's rays which fix this image, with all its range of high lights, shadows and half tones, and you will have an idea of the beautiful drawings which M. Daguerre displayed. . . .

MM. Arago, Biot and Humboldt* have verified the authenticity of this discovery, which excited their admiration, and M. Arago will make it known to the Academy of Sciences in a few days. . . .

Still life, architecture—these are the triumphs of the apparatus that M. Daguerre wants to call after his own name the Daguerotype [sic]. A dead spider, taken through the solar microscope, has such fine detail in the drawing that you could study its anatomy with or without a magnifying glass, as in nature; not a filament, not a duct, as tenuous as it might be, cannot be followed and examined. Travelers, you will soon be able, perhaps at the cost of some hundreds of francs, to acquire the apparatus invented by M. Daguerre, and be able to bring back to France the most beautiful monuments and scenes of the whole world. You will see how far from the truth of the Daguerotype [sic] are your pencils and brushes. Let not the draftsman and painter despair; M. Daguerre's results are something else from their work and in many cases cannot replace it.

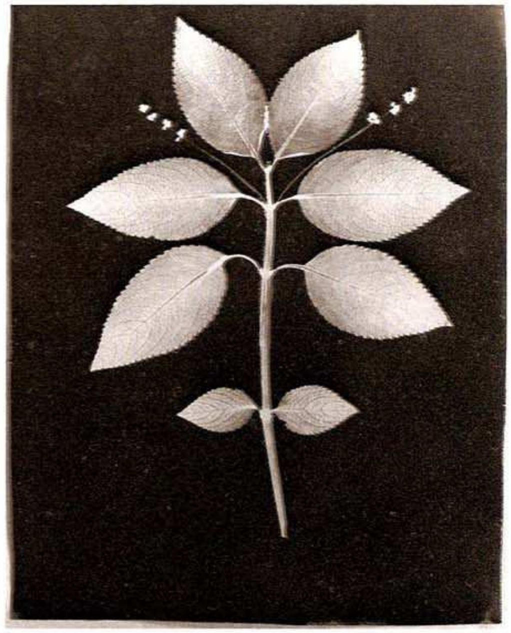
If I wanted to find something resembling the effects rendered by the new process, I would say that they take after copperplate engravings or mezzotints—much more the latter. As to truth, they are above all. . . .[12]

The meeting took place on the following day, and was reported by the Academy in its official publication, the *Cômpte-rendu des Séances de l'Académie des Sciences.* An English translation of the report appeared in the *Literary Gazette* for January 19.

The news of Daguerre's invention astonished William Henry Fox Talbot, English scientist, mathematician, botantist, linguist, and classical scholar, for quite independently he had invented a technique that seemed to him to be identical to Daguerre's. He later wrote that he was "placed in a very unusual dilemma (scarcely to be paralleled in the annals of science)"[13] and rushed to publish his work and thus to claim priority of invention.

Talbot was born in Melbury, Dorset, England in 1800. He had inherited Lacock Abbey, a beautiful country estate not far from Bath. Like so many of the landed gentry, he was educated at Harrow and Cambridge University, where he received the degree of Master of Arts in 1826. Already he had contributed learned papers on

*Jean Baptiste Biot and Alexander von Humboldt, noted scientists and fellow members of the Academy of Sciences, to whom Arago appealed for support.



WILLIAM HENRY FOX TALBOT. *Botanical Specimen.* 1839. Photogenic drawing. Printroom, University of Leiden, The Netherlands.

Sent by Talbot to Jean Baptiste Biot, a member of the French Academy of Sciences.

mathematics and physics to scientific journals, and in 1832 he was elected a Fellow of the Royal Society, England's top scientific body, the equivalent of the French Academy of Sciences.

His discovery of a photographic system came about almost accidentally.

One of the first days of the month of October, 1833 [he later recollected], I was amusing myself on the lovely shores of the Lake of Como in Italy, taking sketches with Wollaston's *camera lucida*, or rather, I should say, attempting to take them: but with the smallest possible amount of success. . . . After various fruitless attempts I laid aside the instrument and came to the conclusion that its use required a previous knowledge of drawing which unfortunately I did not possess. I then thought of trying again a method which I had tried many years before. This method was, to take a *camera obscura* and to throw the image of the objects on a piece of paper in its focus —fairy pictures, creations of a moment, and destined as rapidly to fade away. It was during these thoughts that the idea occurred to me—how charming it would be if it were possible to cause these natural images to imprint themselves durably, and remain fixed upon the paper.[14]

That fall, as soon as he returned to England, Talbot began to experiment.

He bathed paper with a weak solution of common salt (sodium chloride) and then, after it had dried, with a

strong solution of silver nitrate. These chemicals reacted to form silver chloride, a light-sensitive salt insoluble in water, within the paper structure. He placed a leaf, a feather, a piece of lace in contact with this prepared paper and exposed it to sunlight. Gradually the paper darkened wherever it was not protected from light by the opacity of the object in contact with its surface. The result was a white silhouete against the dark ground of the blackened paper, or shadowgraph. Today we should call this a negative image. As early as February 28, 1835 Talbot described how a positive image could be made from the negative. He entered in his notebook:

In the Photogenic or Sciagraphic (Greek: *skia*—a shadow) process, if the paper is transparent, the first drawing may serve as an object, to produce a second drawing, in which the light and shadows would be reversed.[15]

Before this could be done, the negative had to be "fixed," that is rendered insensitive to the further action of light. This Talbot did by washing the paper with a strong solution of salt or with potassium iodide, a treatment that made the unaltered silver salts relatively, but not completely, insensitive to light. This change in property is due to the fact that silver salts differ greatly in their sensitivity to light according to the way they are produced. If a strong solution of salt is added to a weak solution of silver nitrate, the silver chloride that is precipitated is much less sensitive to light than one produced by a weak solution of salt, even though it is identical in chemical structure. Talbot's "preserving" technique was impermanent, and many of the early experiments fixed with strong salt solution have faded—some, indeed, so completely that only Talbot's signature in ink gives evidence that the blank sheet once carried a picture. But at least his process stabilized these "photogenic drawings" to the extent that they could be viewed in daylight, and printed as positives.

Talbot now began to use his invention to record the images made by the camera. The first one he used, he recollected, was made "out of a large box, the image being thrown upon one end of it by a good object glass fixed in the opposite end."[16] An hour's exposure on a summer afternoon left only the impress of the highlights on the paper. But with small cameras, fitted with lenses of relatively large diameter, he had better success, obtaining "very perfect, but extremely small, pictures; such ... as might be supposed to be the work of some Lilliputian artist."[17] One of these is now preserved in the Science Museum, London. It is a negative, hardly an inch square, of a lattice window in Lacock Abbey. He mounted it neatly on a card and wrote beside it: "Latticed Window (with the Camera Obscura) August 1835.—When first made, the squares of glass about 200 in number could be counted, with the help of a lens." He had a collection of box cameras—"little mouse traps," his wife called them —which, upon a summer day, he would train upon the Abbey. "After the lapse of half an hour," he wrote, "I gathered them all up, and brought them within doors to open them. When opened, there was in each a miniature picture of the objects before which it had been placed."[18]

Talbot laid aside these experiments, which he realized were incomplete, and began work on the book, *Hermes, or Classical and Antiquarian Research*. He thought then that perhaps at some later time he would perfect his photogenic drawing process and present it to the Royal Society. There seemed no hurry. But now there was no time to lose. He rushed samples of his work to the Royal Institution in London, where they were shown to the members at the regular Friday evening meeting on January, 25, 1839. They comprised:

flowers and leaves; a pattern of lace; figures taken from painted glass; a view of Venice copied from an engraving; some images formed by the Solar Microscope, viz. a slice of wood highly magnified, exhibiting the pores of two kinds, one set much smaller than the other and more numerous. Another Microscopic sketch, exhibiting the reticulations on the wing of an insect.

Finally: various pictures, representing the architecture of my house in the country; all these made in the summer of 1835.

And this I believe to be the first instance on record, of a house having painted its own portrait.[19]

On January 29, Talbot wrote identical letters to the academicians Arago, Biot, and Humboldt, stating that he would file claim of priority over Daguerre in "fixing the images of the camera obscura and the subsequent preservation of the image so they would bear full sunlight."[20]

On January 31, Talbot's paper, "Some Account of the Art of Photogenic Drawing, or, the Process by which Natural Objects May Be Made to Delineate Themselves without the Aid of the Artist's Pencil," was read at the Royal Society. It was a general description of the results he obtained. Technical details, specific enough to enable anyone to repeat his results, were given in a second paper, read on February 20.

While both Talbot's and Daguerre's processes were still secret, the astronomer and scientist Sir John F. W. Herschel, with characteristic intellectual curiosity and vigor, set about solving the problem independently. In his notebook, now preserved in the Science Museum, London, he wrote: "Jan. 29 [1839]. Experiments tried within the last few days since hearing of Daguerre's *secret* and that Fox Talbot has also got something of the same kind . . . Three requisites: (1) Very susceptible paper; (2) Very perfect camera; (3) Means of arresting the

further action."[21] Like Talbot, he sensitized paper with silver salts. Of his camera we know nothing. His method of "arresting the further action" of light was an epochal contribution. He had noted in 1819 that the hyposulphite of soda dissolved silver salts; now, in 1839, he recorded his successful attempt to use this chemical to fix his photographs.

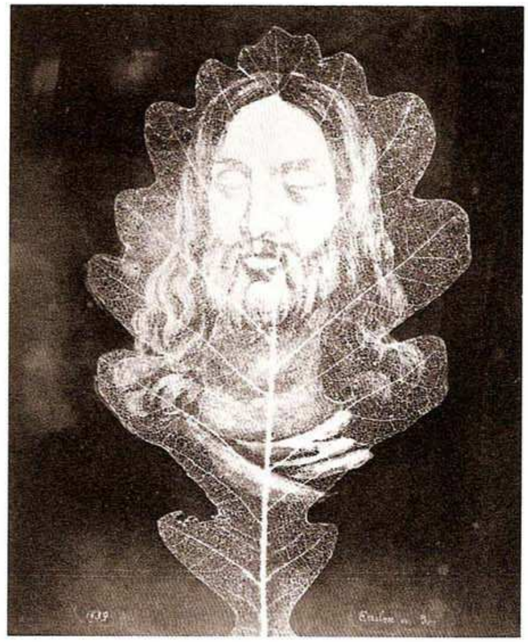
Tried hyposulphite of soda to arrest action of light by washing away all the chloride of silver or other silvering salt. Succeeds perfectly. Papers ½ acted on ½ guarded from light by covering with pasteboard, were when withdrawn from sunshine, sponged over with hyposulphite soda, then well washed in pure water—dried, and again exposed. The darkened half remained dark, the white half white, after any exposure, as if they had been painted in sepia. . . . Thus Daguerre's problem is so far solved."

This chemical is known today as sodium thiosulfate, but photographers still persist in calling it "hypo."[22]

Talbot visited Herschel on February 1 and learned of this fixing technique. He described it, with Herschel's consent, in a letter published in the *Cômpte-rendu* of the French Academy of Sciences.[23] Daguerre at once adopted it. Almost all subsequent photographic processes rely upon Herschel's discovery. Herschel, who was something of a linguist, also proposed "photography" to replace Talbot's somewhat awkward phrase "photogenic drawing" as well as "positive" and "negative" for "reversed copy" and "re-reversed copy." These words were quickly adopted universally.

Materials and apparatus for working Talbot's process soon came on the market. Ackerman & Co., London's leading printseller and purveyor of "Colours & Requisites for Drawing," advertised in April a Photogenic Drawing Box—not a camera, but a packaged kit with chemicals for sensitizing paper and an instruction booklet for making contact prints. In the same month the *Magazine of Science* published facsimiles of three photogenic drawings made, not on paper, but on boxwood blocks sensitized by Talbot's process and subsequently engraved by hand.[24] They were shadowgraphs of a Fool's Parsley seedling, a sprig of Grass of Parnassus, and a piece of lace. This novel use of photography, which eliminated the need for a draftsman to make a drawing upon the block for the engraver to follow, lay fallow until the 1860s, when it revolutionized the craft of wood engraving.

Variations of Talbot's technique were introduced. Of these the most original was devised by the Scotsman Mungo Ponton: instead of sensitizing with a silver salt he used the far less expensive chemical potassium bichromate. The bright orange crystals of this chemical (now also known as potassium dichromate) are normally



Artist unknown. *An Engraving of Christ's Head Superimposed on an Oak Leaf.* 1839. Photogenic drawing. Fox Talbot Collection, The Royal Photographic Society, Bath, England.

soluble in water. On exposure to light they turn brownish gray and become insoluble. Ponton simply brushed a saturated solution of potassium bichromate on paper, let it dry, and then used it to make shadowgraphs. The silhouette of whatever had lain upon the paper during exposure appeared in orange on a brown ground. To fix the image, Ponton simply washed away the still-soluble orange bichromate. Ponton's demonstration of the differential solubility of potassium bichromate according to strength of light action proved to be of the greatest importance in the production of photochemical plates for the printing industry. This use Ponton predicted in his presentation of his technique to the Society of Arts of Scotland on May 25, when he expressed the hope that his process "might be found of considerable practical utility in aiding the operation of lithography."[25]

In May Arago invited Herschel and other British scientists to inspect Daguerre's results in Paris. Herschel was so impressed he said to Arago: "I must tell you that compared to these masterpieces of Daguerre, Monsieur Talbot produces nothing but vague, foggy things. There is as much difference between these two products as there is between the moon and the sun."[26] He wrote Talbot:

It is hardly too much to call them miraculous. Certainly they surpass anything I could have conceived as within the bounds of reasonable expectation. The most elaborate engraving falls far short of the riches and delicateness of execution, every gradation of light and shade is given with a softness and fidelity which sets all painting at an immeasurable distance. His *times* are also very short. In a bright day three minutes suffice. In short, if you have a few days at your disposition, I cannot commend you better than to *come and see*. Excuse this ebullition![27]

Arago now redoubled his efforts to secure a government subsidy for Daguerre and Niépce. He wrote the Minister of the Interior on May 2, with the result that a proposal was made to Daguerre and Isidore Niépce: as recompense for granting the state the right to publish the inventions, they would be awarded generous annuities for life. The partners agreed, and a bill was drawn up for presentation to both houses of the government.

Six of Daguerre's daguerreotypes were put on display at the Chamber of Deputies on July 7. *The Literary Gazette* reported in its July 13 edition:

There were views of three of the streets of Paris, of the interior of M. Daguerre's studio, and a group of busts from the Musée des Antiques. The extraordinary minuteness of such multiplied details as was shown in the street views, particularly in that of the Pont Marie, was much admired. The slightest accidental effects of the sun, or boats, the merchandise on the banks of the river, the most delicate objects, the small pebbles under the water, and the different degrees of transparency which they imparted to it,—everything was reproduced with incredible exactness. The astonishment was, however, greatly increased when, on applying the microscope, an immense quantity of details, of such extreme fineness that the best sight could not seize them with the naked eye, were discovered, and principally among the foliage of the trees. In the view of the studio, all the folds in the draping, and the effects of light and shade produced by them, were rendered with wonderful truth.[28]

After hearing a report by Arago, the Chamber of Deputies passed the bill on July 9 by a vote of 237 to 3. Daguerre demonstrated his process to the Chamber of Peers on August 2; their vote (92 to 4) was also affirmative. The bill became law when it was signed by King Louis Philippe on August 7.[29] Arago was directed to make public technical details at a joint meeting of the Academy of Sciences and the Academy of Fine Arts in the Palace of the Institute.

An eye witness, Marc Antoine Gaudin, relates that

the Palace of the Institute was stormed by a swarm of the curious at the memorable sitting on August 19, 1839, where the process was at long last divulged. Although I came two hours beforehand, like many others I was barred from the hall. I was on the watch with the crowd for everything that happened outside. At one moment an excited man comes out; he is surrounded, he is questioned, and he answers with a know-it-all air, that bitumen of Judea and lavender oil is the secret. Questions are multiplied, but as he knows nothing more, we are reduced to talking about bitumen of Judea and lavender oil. Soon the crowd surrounds a newcomer, more startled than the last. He tells us with no further comment that it is iodine and mercury. . . . Finally the sitting is over, the secret is divulged . . .

A few days later, opticians' shops were crowded with amateurs panting for daguerreotype apparatus, and everywhere cameras were trained on buildings. Everyone wanted to record the view from his window, and he was lucky who at first trial got a silhouette of roof tops against the sky. He went into ecstasies over chimneys, counted over and over roof tiles and chimney bricks, was astonished to see the very mortar between the bricks—in a word, the technique was so new that even the poorest plate gave him indescribable joy.[30]

Daguerre wrote a seventy-nine page booklet, *Historique et description du procédé du Daguérreotype et du Diorama*, which appeared in more than thirty editions, translations, and summaries:[31] to list their places of publication is to plot the spread of the daguerreotype throughout the world: Amsterdam, Barcelona, Berlin, Boston, Copenhagen, Dublin, Edinburgh, Genoa, Graz, Halle, Hamburg, Karlsruhe, Leipzig, London, Madrid, Naples, New York, Paris, Philadelphia, Posnen, Quedlinburg, Rome, Saint Gall, Saint Petersburg, Stockholm, Stuttgart, Tokyo, Vienna, Warsaw. The book contained Arago's report to the Chamber of Deputies, a record of political action taken by the government, a description of Niépce's heliography, and exact technical details of

HIPPOLYTE BAYARD. *Self-Portrait as a Drowned Man.* 1840. Direct paper positive. Société Française de Photographie, Paris.

the daguerreotype process. It was illustrated with scale drawings of the camera and processing equipment. The instructions were so complete that anyone could have the apparatus built by an instrument maker and could obtain some sort of success by following Daguerre's directions carefully.

Daguerre had arranged with his brother-in-law, Alphonse Giroux, for the construction of a supply of cameras and accessories. The cameras were beautifully made of wood and fitted with lenses ground by Chevalier, the Parisian optician who had supplied lenses to both Niépce and Daguerre for their early experiments. These were achromatic telescope objectives of 16-inch focal length, working at an aperture we would today designate as *f*/16.* Each camera bore an ornate label on its side, reading (in translation): "The Daguerreotype. No apparatus is guaranteed unless it bears the signature of M. Daguerre and the seal of M. Giroux." The equipment was put on sale in Paris immediately following publication day and soon was exported to other countries.

Talbot was in Birmingham, attending a meeting of the British Association for the Advancement of Science, just after Daguerre's process was disclosed. He had brought a collection of his photogenic drawings, which he put on display. On August 26 he addressed the members on the daguerreotype. He stated that he had long since studied the light sensitivity of silver iodide but found it too weak to be of practical use; Daguerre's contribution, he noted, was that a feeble image "can be increased, brought out, and strengthened at a subsequent time, by exposing the plate to the vapours of mercury."[32]

The publication of the photographic processes of Talbot and Daguerre brought forth a host of claimants for priority. Of these, the most convincing came from Brazil and Norway.

Hercules Florence, a Frenchman living in Brazil, claimed that as early as 1832 he made photographs with a camera and by contact printing. His notebooks, written between 1833 and 1837, contain clear descriptions of his technique—and what is even more remarkable—he used the word "photographie" at least two years before Herschel suggested "photography" to Talbot. Contact prints of a diploma and labels for pharmaceutical bottles made by Florence before 1837 exist, though none of his camera work appears to have survived.

Hans Thøger Winther, a Norwegian lawyer, proprietor of a lithographic printing shop and a book publisher, claimed that in 1826 he had the idea of fixing the camera image by the use of light-sensitive materials, and that he succeeded in making direct positives before the disclosure of Daguerre's process. His experiments, however, have not yet been located.

The most luckless pioneer was Hippolyte Bayard, a clerk in the French Ministry of Finance, who exhibited thirty photographs in Paris on July 14, 1839. His method was original: silver chloride paper was held to the light until it turned dark. It was then plunged into potassium iodide solution and exposed in the camera. The light bleached the paper in proportion to its strength, and he thus obtained direct positives, each unique.

In the spectacular publication of the daguerreotype the work of Bayard was completely overlooked. He commented on his misfortune in a photograph dated 1840. He showed himself half naked, propped up against a wall as if dead. On the back of the print he wrote:

> The body you see is that of Monsieur Bayard. . . . The Academy, the King, and all who have seen his pictures admired them, just as you do. Admiration brought him prestige, but not a sou. The Government, which gave M. Daguerre so much, said it could do nothing for M. Bayard at all, and the wretch drowned himself.[33]

Happily, Bayard lived on, to make handsome photographs using both Daguerre's and Talbot's techniques. Both methods became fully practical and reigned supreme throughout the world for almost two decades.

*A number obtained by dividing the focal length of a lens by its maximum diameter. All lenses with the same *f*-number form images of equal brilliance of the same subject. This system of lens marking, which originated in the nineteenth century, was adopted as an international standard at the International Congress of Photography held in Paris in 1900.